

CLAIMS

1. A method for forming an LED, the method comprising bonding a heat generating region of a light emitting device to a heat conductive substrate so as to define a composite structure and so as to substantially enhance heat dissipation from the light emitting device.
2. The method as recited in claim 1, wherein bonding a heat generating region of a light emitting device to a heat conductive substrate comprises bonding a heat generating region of a light emitting device directly to a heat conductive substrate.
3. The method as recited in claim 1, wherein bonding the heat generating region of a light emitting device to a heat conductive substrate comprises bonding a heat generating region comprising the following to the heat conductive substrate:
 - an active layer;
 - an n-doped layer; and
 - a p-doped layer.
4. The method as recited in claim 1, wherein bonding the heat generating region of a light emitting device to a heat conductive substrate comprises bonding a heat generating region comprising the following to the heat conductive substrate:
 - an active layer;
 - an n-doped layer,
 - a p-doped layer; and
 - metal bonding layer.
5. The method as recited in claim 1, wherein bonding the heat generating region of a light emitting device to a heat conductive substrate comprises bonding a heat generating region comprising the following to the heat conductive substrate:
 - a transparent substrate;
 - an active layer;
 - an n-doped layer,

a p-doped layer; and
metal bonding layer.

6. The method as recited in claim 1, wherein bonding the heat generating region of a light emitting device to a heat conductive substrate comprises bonding a heat generating region comprising the following to the heat conductive substrate:

an active layer;
an n-doped layer;
a p-doped layer,
a reflector layer ; and
metal bonding layer.

7. The method as recited in claim 1, wherein bonding the heat generating region of a light emitting device to a heat conductive substrate comprises bonding a heat generating region comprising the following to the heat conductive substrate:

a transparent substrate;
an active layer;
an n-doped layer;
a p-doped layer,
a reflector layer ; and
metal bonding layer.

8. The method as recited in claim 1, wherein bonding the heat generating region of a light emitting device to a heat conductive substrate comprises bonding a heat generating region directly to a heat conductive substrate comprising:

a silicon layer; and
a metal bonding layer.

9. The method as recited in claim 1, wherein the heat generating region of the light emitting device comprises:

a transparent substrate;
an active layer;
an n-doped layer;

a p-doped layer,
a reflector layer ;
metal bonding layer;
and the heat conductive substrate comprises:
a silicon layer; and
a metal bonding layer.

10. The method as recited in claim 1, wherein the heat generating region of the light emitting device comprises a metal bonding layer and the heat conductive substrate comprises a metal bonding layer and further comprising cleaning both metal bonding layers prior to bonding the heat generating region of a light emitting device to the heat conductive substrate.
11. The method as recited in claim 1, wherein bonding a heat generating region of a light emitting device to a heat conductive substrate comprises bonding a plurality of light emitting devices to a single heat conductive substrate.
12. The method as recited in claim 1, wherein bonding a heat generating region of a light emitting device to a heat conductive substrate comprises bonding a plurality of light emitting devices of a single color to a single heat conductive substrate.
13. The method as recited in claim 1, wherein bonding a heat generating region of a light emitting device to a heat conductive substrate comprises bonding a heat generating region of a light emitting device to a heat conductive substrate using a wafer bonding fixture.
14. The method as recited in claim 1, wherein the light emitting device comprises a transparent substrate and the transparent substrate comprises at least one material selected from the group consisting of:
ZnO;
Sapphire
Spinel;
MgO;

GaN;
AlN;
AlGaN; and
AlInGaN.

15. The method as recited in claim 1, wherein the light emitting device comprises:
an n type semiconductor material; and
a p type semiconductor material disposed proximate the n type semiconductor material so as to define an active layer.
16. The method as recited in claim 1, wherein the light emitting device comprises:
n type gallium nitride; and
p type gallium nitride disposed proximate the n type gallium nitride so as to define an active layer.
17. The method as recited in claim 1, wherein the light emitting device comprises n type gallium nitride, p type gallium nitride disposed proximate the n type gallium nitride so as to define an active layer, and wherein the active layer comprises at least one structure selected from the list consisting of:
a double heterostructure;
a single quantum well structure; and
a multiple quantum well structure.
18. The method as recited in claim 1, further comprising forming an n-electrode and a p-electrode on the same side of the composite structure.
19. The method as recited in claim 1, wherein the light emitting device comprises a reflector layer comprising a metal layer comprising one of the Al, Ag, Au, Cr.
20. The method as recited in claim 1, wherein the light emitting device comprises a metal bonding layer which comprises a metal selected from the group consisting of:
Ni;
Pt;

Au; and
Ti.

21. The method as recited in claim 1, wherein the heat conductive substrate comprises a material selected from the group consisting of:
 - silicon;
 - Ge;
 - SiC;
 - GaAs;
 - InP;
 - GaP
 - ZnO; and
 - a metal.
22. The method as recited in claim 1, further comprising forming an n electrode upon the composite device.
23. The method as recited in claim 1, further comprising forming a passivation layer upon the composite device.
24. The method as recited in claim 1, further comprising forming positive and negative bonding pads upon the composite device.
25. An LED comprising a light emitting device having a heat generating region and a heat conductive substrate to which the heat generating region is bonded, so as to define a composite structure and so as to substantially enhance heat dissipation from the light emitting device.
26. The LED as recited in claim 25, wherein the heat generating region of the light emitting device is bonded directly to the heat conductive substrate.
27. The LED as recited in claim 25, wherein the heat generating region comprises:
 - an active layer;
 - an n-doped layer; and

a p-doped layer.

28. The LED as recited in claim 25 , wherein the heat generating region comprises:
 - an active layer;
 - an n-doped layer;
 - a p-doped layer; and
 - metal bonding layer.
29. The LED as recited in claim 25 , wherein the heat generating region comprises:
 - a transparent substrate;
 - an active layer;
 - an n-doped layer,
 - a p-doped layer; and
 - metal bonding layer.
30. The LED as recited in claim 25 , wherein the heat generating region comprises:
 - an active layer;
 - an n-doped layer;
 - a p-doped layer,
 - a reflector layer ; and
 - metal bonding layer.
31. The LED as recited in claim 25 , wherein the heat generating region comprises:
 - a transparent substrate;
 - an active layer;
 - an n-doped layer;
 - a p-doped layer;
 - a reflector layer; and
 - metal bonding layer.
32. The LED as recited in claim 25 , wherein the heat conductive substrate comprises:
 - a silicon layer; and

a metal bonding layer.

33. The LED as recited in claim 25 , wherein the heat generating region of the light emitting device comprises:

- a transparent substrate;
- an active layer;
- an n-doped layer;
- a p-doped layer;
- a reflector layer ;
- metal bonding layer;

the heat conductive substrate comprises:

- a silicon layer; and
- a metal bonding layer.

34. The LED as recited in claim 25 , wherein the heat generating region of the light emitting device comprises a metal bonding layer and the heat conductive substrate comprises a metal bonding layer.

35. The LED as recited in claim 25 , wherein a plurality of light emitting devices are bonded to a single heat conductive substrate.

36. The LED as recited in claim 25 , wherein a plurality of light emitting devices of a single color devices are bonded to a single heat conductive substrate.

37. The LED as recited in claim 25 , wherein the light emitting device comprises a transparent substrate and the transparent substrate comprises at least one material selected from the group consisting of:

- ZnO;
- Sapphire;
- Spinel;
- MgO;
- GaN;
- AlN;

AlGa_N; and
AlInGa_N.

38. The LED as recited in claim 25 , wherein the light emitting device comprises:
an n type semiconductor material; and
a p type semiconductor material disposed proximate the n type semiconductor material so as to define an active layer.
39. The LED as recited in claim 25 , wherein the light emitting device comprises:
n type gallium nitride; and
p type gallium nitride disposed proximate the n type gallium nitride so as to define an active layer.
40. The LED as recited in claim 25 , wherein the light emitting device comprises n type gallium nitride, p type gallium nitride disposed proximate the n type gallium nitride so as to define an active layer, and wherein the active layer comprises at least one structure selected from the list consisting of:
a double heterostructure;
a single quantum well structure; and
a multiple quantum well structure.
41. The LED as recited in claim 25 , further comprising an electrode formed upon the composite structure.
42. The LED as recited in claim 25 , further comprising an electrode of p type semiconductor material formed upon the composite structure.
43. The LED as recited in claim 25 , wherein the light emitting device comprises a reflector comprising a metal layer that comprises one of the Al, Ag, Au, Cr.
44. The LED as recited in claim 25 , wherein the light emitting device comprises a metal bonding layer which comprises a metal selected from the group consisting of:
Ni;

Pt;
Au; and
Ti.

45. The LED as recited in claim 25 , wherein the heat conductive substrate comprises a material selected from the group consisting of:
- silicon;
 - Ge;
 - SiC;
 - GaAs;
 - InP;
 - GaP;
 - ZnO; and
 - a metal.
46. The LED as recited in claim 25 , further comprising an n electrode formed upon the composite device.
47. The LED as recited in claim 25 , further comprising a passivation layer formed upon the composite device.
48. The LED as recited in claim 25 , further comprising positive and negative bonding pads formed upon the composite device.
49. An LED chip comprising a conductive substrate formed generally at one surface thereof, a transparent emitting substrate formed generally at another surface thereof and attached thereto by a direct wafer bonding technique, and backside via contacts.
50. The LED chip as recited in claim 49 , wherein the conductive substrate comprises at least one material selected from the group consisting of:
- Si;
 - Ge;
 - SiC;

GaAs;
InP;
GaP;
ZnO; and
metal substrates.

51. The LED chip as recited in claim 49, wherein the transparent substrate comprises at least one material selected from the group consisting of:
- sapphire;
 - spinel;
 - ZnO;
 - SiC;
 - MgO;
 - GaN;
 - AlN;
 - AlGaN; and
 - AlInGaN.
52. A reflective electrode comprising a single layer of reflective material formed upon p type gallium nitride layer, an n+ type gallium nitride interlayer formed intermediate the reflective material and the p type gallium nitride layer, and at least one ohmic contact layer formed to the p type gallium nitride layer.
53. A reflective electrode comprising a plurality of layers of reflective material formed upon p type gallium nitride layer, an n+ type gallium nitride interlayer formed intermediate the reflective material and the p type gallium nitride layer, and at least one ohmic contact layer formed to the p type gallium nitride layer.